Circularly Polarized Optical Spots beyond the Diffraction Limit

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Diffraction-limited circularly-polarized electromagnetic radiation has been widely used in the literature for various applications at both optical and microwave frequencies. With advances in nanotechnology, circularly-polarized electromagnetic radiation beyond the diffraction limit is desired in emerging plasmonic nano-applications, such as all-optical magnetic recording. In the literature, it has been demonstrated that the magnetization can be reversed in a reproducible manner by using a circularly polarized optical beam without any externally applied magnetic field. To advance the areal density of hard disk drives beyond 1 Tbit/in.^{2}, magnetization reversal areas much smaller than 100 nm are required. To achieve sub-100 nm bits, circularly polarized optical spots beyond the diffraction limit are necessary.

In this study, a cross-dipole nano-antenna is investigated to achieve circularly polarized near-field radiation beyond the diffraction limit. The cross-dipole nano-antenna is composed of four gold metallic nano-rods placed at a vertical orientation with respect to each other. In addition to providing an intense optical spot in the vicinity of its gap, two conditions that are required for circular polarization are met: (1) the phase difference between the electric field components is 90° and (2) the ratio of the magnitudes of the electric field components is equal to 1 in the vicinity of the gap.

The near-field radiation characteristics of a plasmonic cross-dipole nano-antenna are investigated when illuminated with linearly-polarized and circularly-polarized incident radiation. It is found that a plasmonic cross-dipole nano-antenna can achieve an intense and circularly-polarized optical spot sized smaller than the diffraction-limit of incident light. Amplitude-ratio and phase-difference between field components are compared for linearly and circularly polarized optical spots beyond the diffraction limit. In addition, various antenna configurations are investigated to achieve light localization, circular polarization, and intensity enhancement.